Asset Co-movements and the Effects of the Global Financial Crisis in Europe

Cross-asset Linkages between Stock and Bond Markets and a Cross-country Stock Market Analysis

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Abstract

This paper intends to analyze cross-asset linkages in the five largest European economies prior to and after the Global Financial Crisis. The study contains an OLS regression analysis for each country on a yearly basis from 2006 to 2012 examining cross-asset linkages between stock and government bond markets concentrating on the theories of contagion and flight-to-quality. Additionally, the same method has been used to study the cross-country linkages between stock markets in the five countries during a period of 2006-2010.

The study's relevance is in the financial asset pricing and it generates information on how the different asset markets move in relation to each other during financial distress which can have an impact on the (international) diversification decisions. The key finding from the cross-country analysis was that almost all countries showed bi-directional contagion between their stock markets indicating a possible downside to economic integration. The findings from the cross-asset analysis, on the contrary, seemed to be more country-specific in terms of contagion and flight-to-quality.

Key Concepts
Asset Linkages, Spill-overs, Asset Market Co-movement, Flight-to-quality, Contagion, Global Financial crisis, Financial stress, Economic integration, Market Crashes

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Definitions

(G)ARCH: (General) Autoregressive Conditional Heteroskedasticity is a time series model for measuring volatility.

Bi-directional contagion: contagion that affects both ways *e.g.* from GB to DE and from DE to GB. See contagion.

EZDC: Eurozone debt crisis that evoked in the end of 2009 when some of the member states' governments ran into debt.

Co-movement: two asset classes moving together in correlation.

Contagion: the cross-market correlation coefficient's significant increase during a time of an economic distress meaning that when one market is affected by a shock it has ripple effect to other markets.

Cross-asset linkages: the co-movement of two asset classes: stocks and bonds. See co-movement.

Cross-country linkages: the co-movement of two countries' asset classes: stocks. See co-movement.

Five largest economies in the EU: the United Kingdom (GB), France (FR), Germany (DE), Spain (ES) and Italy (IT) measured by GDP.

Flight-from-quality: see flight-to-quality. The correlation change exists in a bond market crisis.

Flight-to-quality: stock market uncertainty leads to increases in bond prices in a relation to stocks, and simultaneously the co-movement based returns between two asset classes become less positively correlated. Bond market booms in a relation to stock market.

G5: the five largest countries (the United States, the United Kingdom, France, Japan and Germany) in G20 that are studied in the Hartmann et al. (2004) study.

GFC: *Global financial crisis* that evoked in 2007-2008 in the U.S. and expanded globally to other regions of the world causing recession, bailouts, unemployment, defaults and insolvency.

Interdependence: opposite to contagion. An insignificant increase in correlation despite the strong level of market co-movement between the assets.

OLS: Ordinary Least Squares, a method to study regressions.

Spill-over effect: an economic event that occurs in one context and floods to another independent context.

Stock market crash: a 20% or more price loss in one week.

Unsystematic risk: unique, firm-specific risk that can be diversified away.

1. Introduction

"What we know about the global financial crisis is that we don't know very much."
-Paul Samuelson, a Nobel Memorial Prize winner in Economic Sciences

As an investor, it is beneficial to understand the effects of a crisis and its severity to different asset classes. Therefore, the diversification of a portfolio is affected by the successful implementation of adapting the investment portfolio to the contemporary market circumstances. Thus, any new information produced about the effects of a financial crisis is important from the perspective of asset pricing in finance to an individual investor. Investment decisions are made based on the tradeoff of risk and return. A risk-averse investor is more reluctant to invest in uncertain assets in contrast to a risk-loving investor who seeks for high-yielding returns on their investments. Thus, it is important to study how the markets are affected by the crisis in terms of investment decision-making.

This paper examines asset market linkages from an investor's perspective by analyzing co-movements of stock and bond markets before and after the Global Financial Crisis (GFC) within the five largest economies in the EU (Germany, France, the United Kingdom, Italy and Spain) based on GDP during the time period of 2006-2012. The study focuses explicitly on cross-asset linkages (between stock markets and government bond markets) which are vital in terms of analyzing international financial stability.[1] Moreover, the paper addresses the impacts of the GFC on the European stock and bond market co-movements and whether it constitutes contagion in the stock market. Forbes and Rigobon (2002) define contagion as the cross-market correlation coefficient's significant increase during a time of an economic distress.[2] Therefore, if the results from this study show a strong degree of contagion it can be further presumed that this phenomenon presents a disadvantage of economic integration. Flight-to-quality phenomenon, on the other hand, addresses the cross-asset linkages by stating that if a stock market crashes it affects the bond market with the increase of bond prices *i.e.* the correlation coefficient has a significant decrease.

[1] Hartmann, P., S. Straetmans, and C. G. De Vries. 2004. "Asset Market Linkages in Crisis Periods." *Review of Economics and Statistics* 86.1 p.313
[2] Forbes K, Rigobon R. 2002. No contagion, Only Interdependence: Measuring Stock Market Comovements. Journal of Finance 5: 2223-2261. p.1

Economic integration, especially the formation of the European Union (EU) and the Economic and Monetary Union (EMU), has affected dependencies between European countries. After the start of the GFC in 2007-2008 that spread to Europe, several member states were incapable of refinancing their government debt generating the European sovereign debt crisis also referred to as the Eurozone debt crisis (EZDC). The interest of this paper lies during the period of these crises and how stock and bond markets are affected by the turmoil. In order to study the linkages between stock and bond markets, an Ordinary Least Square (OLS) method is utilized in this paper to study the regressions.

1.1. Introduction of the Research Problem

Hartmann *et al*. (2004) emphasize the importance of the research of cross asset linkages by stating that the severity of the real effects following a crisis might be determined by the number of markets affected by the situation.[3] Previous research on the international crash of 1987 (also referred to as "Black Monday") conducted by Roll (1988) already suggests that the asset returns tend to co-move more strongly during economic turndowns. In his study Roll (1988) examined all the available data from 1981 to 1987 and concluded that the only month when all the markets co-moved in the same direction was in October 1987 when all the stock markets dropped and most even more than 20 per cent.[4] In 2004, Hartmann *et al*. conducted a similar research focusing on the G-5 countries (Japan, the United States, the United Kingdom, Germany and France) aiming to examine the linkages in asset returns in times of financial crisis by using an external dependence measure.[5] In contrast, according to some scholars (Hunter & Simon, 2004; Connolly *et al*., 2005) cross-asset correlations tend to decrease generally during the period of crises, especially between stock and bond markets.

Since the study from Hartmann *et al.* was published in 2004, the world economy has encountered some major changes; namely the GFC and the EZDC. Thus, the research puzzle encompasses whether the results of previous studies can be applied to the co-movements of

[3] Hartmann *et al.*, 2004, p. 313
[4] Roll, Richard. "The International Crash of October 1987." *Financial Analysts Journal* 44.5 (1988): 19-35. Web. 9 Apr. 2015. p.22
[5] Hartmann *et al.*, 2004, p.313.

stock and bond asset markets in the five largest economies in the EU affected by the GFC. Therefore, the paper conducts a study inspired by Hartmann *et al.* (2004) using contemporary data. The paper's objective is to examine if these findings from previous literature still hold in the current economy using the most contemporary crisis and how the tendencies of extreme co-movements between stocks and bonds might have changed over time.

Therefore, the paper poses the following research questions:

How have the tendencies of co-movements between stocks and bonds changed in the European markets prior to and during the Global Financial Crisis?

How have the stock co-movements changed across countries prior to and during the crisis period?

The hypotheses underlying the research questions are derived from the results of previous research:

1. The expectation is that the correlation and thus, the co-movement, is stronger during the crisis period. According to the results by Hartmann *et al.* (2004), stock markets tend to co-crash more often than bond markets. The phenomenon of contagion tends to occur with the same likelihood that the phenomenon of flight-to-quality. In addition, they find that national linkages and cross-border linkages tend to be similar, presenting a downside for international economic integration.

2. The second hypothesis is derived from the article by Forbes (2013). The author suggests that since the economically linking factors between the European countries have increased, it has resulted in high levels of interdependence and contagion. Thus, it can be expected that the results of the cross-country analysis should show strong correlations and thus, high contagion effects.

1.2. Introduction to Previous Research

The most relevant literature covered in the chapter of previous research focus on the article by Hartmann *et al.* (2004). Other significant studies introduced in this paper include articles from Dua & Tuteja, 2014; Hamao *et al.*, 1990; Horvath & Poldauf, 2012 and King & Wadhwani, 1990. While the research conducted by Hartmann *et al.* (2004) represents the core inspiration to this paper, the other articles mentioned above are, however, vital for understanding the underlying theories behind the phenomenon of asset linkages. Section two introduces some of the main concepts and methods used in previous research, such as contagion and flight-to-quality.

1.3. Aim and Knowledge Contribution

Previous studies have mostly focused on either asset market linkages without including the latest GFC effects to Europe or the studies' data have been gathered to cover a different region. In addition, besides the study by Hartmann *et al.* (2004), very few authors have approached the phenomenon by looking at cross asset linkages. Instead, most of the existing literature covers only asset linkages of stock markets across different countries *i.e.* cross-country analyses. Consequently, the study of cross asset linkages of the five largest EU economies affected by the GFC contributes to the field of asset pricing in finance. The thesis' purpose is to illustrate the plausible asset linkages (cross-asset linkages in national markets, as well as cross-border linkages in stock markets) by looking at the most recent global crisis' effects in Europe. By analyzing the phenomenon from an updated data perspective the paper tests the hypothesis derived from the results of the study by Hartmann *et al.* (2004) and Forbes (2013).

The following order provides an outline for the paper where chapter 1 introduces the research problem related to the co-movements between asset classes during the period of crisis, namely the GFC, in terms of phenomena of flight-to-quality and contagion which are discussed more deeply in chapter 2 that covers the most relevant previous literature to this paper with some additional theoretical framework concepts. Chapter 3 addresses the used method, OLS, and various tests that are performed on the data following by the deep analysis that is divided into

two sections: *cross-asset* and *cross-country linkages.* The paper discusses the results of the paper in a relation to previous literature in chapter 5 and continues to the conclusion in chapter 6 respectively. Lastly, the paper poses some limitations that may arise in terms of conducting a study with the chosen method in chapter 7.

2. Literature Review

The paper investigates the effect of the GFC and the EZDC on the co-movement of stock and bond market asset returns and whether this correlation follows a similar pattern than the one investigated in the study by Hartmann *et al.* (2004) using contemporary data. This section introduces the main concepts, theories, analytical models and findings used in existing literature that are relevant to the subject.

2.1. Previous Research

According to Hartmann *et al.* (2004), Morgenstern (1959) was the first scholar to study the phenomenon of contagion where a financial crisis spills over to another country. In his study, Morgenstern examines 23 stock market crashes' effects to other countries' markets. More recent previous literature, focuses mainly on stock market co-movements and the difference of the phenomenon in non-crash times compared to times of market turmoil. In addition, the focus for these studies has been on the phenomenon of contagion and its direction. Some representative literature of this has been presented below in this essay. However, as Hartman *et al.* note (2004), there is very little research conducted on bond market spill-overs.[6] Therefore, this paper intends to cover the knowledge gap in bond market linkages by including the bond market indices to the research.

Considerable amount of previous literature during the 1990s investigates the crash of October 1987 ("Black Monday"). King & Wadhwani (1990) as well as Malliaris & Urrutia (1992) are examples of these types of studies. King & Wadhwani (1990) provide evidence to the phenomenon of contagion, whereas Malliaris & Urrutia (1992) suggest that the crash of 1987

[6] Hartmann *et al.*, 2004, p. 313

was international and started simultaneously in all the national stock markets[7].[8] In 1994 King *et al.* published another article concentrating on the links between 16 different stock markets and their volatility. Thus, the focus of the study was on the time-variation in the covariances. They use a multivariate factor model which is a version of Arbitrage Pricing Theory and their findings suggest that the idiosyncratic (*i.e.* unique) risk is different across countries and significantly priced. In addition, they conclude that the reasons for the changes in the correlation coefficients in the cross-market analysis are primarily in the movements in "unobservable" variables.[9]

Hamao *et al.* (1990) studied the price volatility and its interdependence among international stock markets also using the GARCH (1, 1) model as their method. In the study they examined three major stock exchanges: TSE (Nikkei 225), NYSE (S&P 500) and London Stock exchange (FTSE 100). They focus of their study can be concluded into two dimensions. First, they examine the extent to which price changes affect another market's opening prices and second, they examine whether the price volatility relates positively to another market's price volatility.[10] Their results show evidence of UK and U.S. stock market spill-overs to the Japanese stock market but the effect is much weaker to the other two markets.[11] Furthermore, Lin *et al.* (1994) study the linkages between New York and Tokyo stock markets also using a GARCH based model. Contrary to the results by Hamao *et al.* (1990), they suggest that the interdependence between New York and Tokyo markets is "bi-directional" in terms of returns and volatility.[12]

The study by Hartmann *et al.* (2004) accounts as the basic inspiration to this paper. The research includes the G-5 countries (the United States, the United Kingdom, Japan, France and Germany) and investigates the co-movement of extreme asset linkages during crisis periods. They argue that using a non-parametric measure instead of a correlation analysis gives a more valid outcome since it is not predisposed towards normal distribution and can thus additionally

[7] Their study constitutes six major stock market indices: New York S&P 500, Tokyo Nikkei, London Fr-30, Hong Kong Hang Seng, Singapore Straits Times, and Australia All Ordinaries.
[8] Malliaris, Anastasios G., and Jorge L. Urrutia. "The international crash of October 1987: causality tests." *Journal of Financial and Quantitative Analysis* 27.03 (1992). p.353
[9] King, Mervyn, Enrique Sentana, and Sushil Wadhwani. "Volatility and Links between National Stock Markets." *Econometrica* 62.4 (1994): 901. p. 901
[10] Hamao, Yasushi, Ronald W. Masulis, and Victor Ng. "Correlations in price changes and volatility across international stock markets." *Review of Financial studies* 3.2 (1990). p. 282
[11] Hamao *et al.*, 1990, p.306
[12] Lin, Wen-Ling, Robert F. Engle, and Takatoshi Ito. "Do bulls and bears move across borders? International transmission of stock returns and volatility. *"Review of Financial Studies* 7.3 (1994). p. 536.

capture non-linear relationships.[13] As this paper's hypotheses reveal, their findings suggest that the probabilities of simultaneous crashes between stock markets are much higher than between bond markets. Moreover, the probabilities of cross-asset contagion between stock and bond markets and flight-to-quality from stock into bonds are approximately the same. Additionally, the cross-border and national linkages show surprisingly similar results, representing a potential disadvantage for economic integration.[14] The study by Hartmann *et al.* (2004) contributes to the field of existing literature by adding the linkages between different types of asset classes and using a methodology based on bivariate extreme value theory (as opposed to the existing literature that has only considered one asset class at a time and used the methodology of either a simple cross-country correlation analysis or the ARCH model).

An article published in 2007 by Bartram *et al.* covers a similar type of study. The authors have investigated the impact on the co-movement of European stock markets after introducing the Euro. The study includes 17 European stock markets between 1994 and 2003. Despite taking a somewhat different perspective than this research (focusing on the introduction of a new common currency instead of a market crash), the research by Bartram *et al.* (2007) gives relevant information on the empirical study of stock co-movements between European countries using a type of GARCH model. The paper by Bartram *et al.* (2007) thus, introduces a new model that is a more direct and general copula for capturing the time-varying dependence between financial asset prices. "Specifically, the model uses a GJR-GARCH-MA-*t* specification for the marginal distributions and the Gaussian copula for the joint distribution."[15]

There are also more recent studies on asset market linkages. However, these studies are mostly using data outside Europe or before the start of the GFC. Examples of these studies include Rodriguez (2007) and Forbes & Rigobon (2002) who study contagion during the Asian crisis and the Mexican crisis. In addition, Horvath & Poldauf (2012) study the asset linkages during the GFC using data from stock markets in Australia, Brazil, Canada, China, Germany, Hong Kong, Japan, Russia, South Africa, the United Kingdom, and the U.S. Their findings prove that the strongest correlation can be found between the U.S. stock market and the stock markets in Brazil, Canada and the United Kingdom. The correlation between the U.S. and China, however,

[13] Hartmann *et al.*, 2004, p. 313

[14] The concepts of Contagion and Flight-to-quality have been explained more in detail later in chapter 2.2 of theoretical framework.

[15] Bartram, Söhnke M., Stephen J. Taylor, and Yaw-Huei Wang. "The Euro and European Financial Market Dependence." *Journal of Banking & Finance 31*.5 (2007): 1461-481. p.1462

was zero prior to the GFC and turned slightly positive during the GFC.[16] A study by Didier *et al.* (2011) also examines the GFC's effects to asset returns. The authors have divided the data to before and after the collapse of Lehman Brothers and they study the factors that affect the co-movements between returns in U.S. stock market and stock market returns in 83 other countries. Their findings conclude the reasons to be financial linkages. Kim & Kim (2010), on the other hand, study the effects of the U.S. financial crisis on the Asian economies. They utilize the GARCH model to analyze spill-overs in five different emerging Asian economies: Indonesia, Taiwan, Thailand, Korea and the Philippines. Similarly to the study by Didier *et al.* (2011), the start of the crisis has been determined by the collapse of Lehman Brothers in 2008. The authors conclude that the results show contagion from the U.S. markets to the emerging Asian markets that is "short-lived", however, "non-negligible".[17]

Moreover, most of the recent literature covering European markets only covers stock market linkages. An example of these kind of studies is Dua & Tuteja (2014) who study contagion during the GFC and the EZDC. However, their study concentrates on stock markets and exchange rates. In terms of stock market spill-overs, they find proof of significant contagion.

Most of the reviewed literature lacks in considering the most contemporary crisis effects in Europe in their data analysis as well as cross asset linkages between stock and bond markets examining the phenomenon of flight-to-quality. In order to test the hypothesis built in previous studies that the asset returns co-move more strongly during crises periods this paper extends the data material to the recent GFC and the EZDC including bond markets into the analysis.

2.2. Theoretical Framework

This part of the paper addresses the relevant theories and background information about the GFC. The two main theories: contagion and flight-to-quality are scrutinized in order to study cross-asset and cross-country linkages.

[16] Horvath, Roman, and Petr Poldauf. "International stock market comovements: what happened during the financial crisis?" *Global Economy Journal* 12.1 (2012). Abstract.
[17] Kim, Hyeongwoo, and Bong-Han Kim. "Spillover effects of the US financial crisis on financial markets in emerging Asian countries." *Available at SSRN 1604650* (2010). p.17

2.2.1. Financial Markets, the Global Financial Crisis and the Eurozone Debt Crisis

The financial crisis of 2007-2008 originated from the United States but expanded to other economies worldwide. The fundamental causes according to G20 are based on the extreme regulation and supervision failures in the financial sector.[18] These failures appeared as acts of the U.S. financial institutions to lend speculative mortgages and the international banks' trading activities concerning resultant derivative securities, leading to a vast bubble in 2001-2007, and finally resulting to the GFC and recession.[19] The consequences of the GFC were horrendous, leading to a decline in stock markets and real estate, bailouts of banks by national governments, foreclosures and unemployment.

Despite the fact that the crisis began from the U.S. it spread globally within six months of its outbreak.[20] Subsequently, the GFC of 2007-2008 contributed to the EZDC that evoked in the end of 2009. According to Lapavitsas *et al.* (2012), hazardous integration of the peripheral countries in the Eurozone aggravated by the structural weakness of the monetary union were the reasons for the start of the sovereign debt crisis that erupted in Greece at the end of 2009.[21]

The focus of the paper is on the five largest EU economies (Germany, France, the United Kingdom, Italy and Spain) based on Hartmann *et al.*'s (2004) study of five of the largest economies in G20. The GFC and the EZDC impacted on these countries differently based on their economic conditions. Spain and Italy are considered as peripheral countries of the Eurozone that got into deep troubles due to the governments' debts. *Vice versa*, Germany and France are part of the core of the Eurozone. Germany managed to avoid the household debt that took place in many EU countries based on its account surplus within the Eurozone which again, was invested to foreign direct investments.[22] According to Lapavitsas *et al.* (2012) the contagion effects rose in the core countries due to the crisis in 2010-2011. Italy, which has stood in between of the periphery and the core, was primarily affected by this phenomenon.[23] Despite

[18] Ravenhill, John, ed. (2014): *Global Political Economy*. Oxford University Press (4th ed.) p.6
[19] Lapavitsas, Costas. "Beggar Thyself and Thy Neighbour." Crisis in the Eurozone. London: Verso, 2012. Print. p.1
[20] Meric, Gulser and Lentz, Christine and Smeltz, Wayne and Meric, Ilhan, International Evidence on Market Linkages after the 2008 Stock Market Crash (2012). The International Journal of Business and Finance Research, v. 6 (4) p. 45
[21] Lapavitsas, 2012, p.1
[22] Lapavitsas, 2012, p.2
[23] Lapavitsas, 2012, p.156

not being included in the Eurozone, the United Kingdom was also affected by the GFC. In the 4th quarter of 2008, GDP of the United Kingdom fell by 1.5% meaning that the country was officially hit by the GFC.

2.2.2. Shocks in Stock and Bond Markets –Crisis Period

Since the purpose of the paper is to study how a crash in one asset class affects another asset class, it becomes relevant to define what is considered as a crash. To get an idea one can first consider the term 'shock'. Shock is often defined as an (unexpected) change in a variable or occasionally as the value of the error term in a certain time period.[24] There are many ways a shock can rise in stock-bond markets. According to Meric *et al.* (2012) the stock market crash in the U.S. began on October 9, 2007 when the markets hit their all-time highs until in March 9, 2009 the markets crashed and hit the bottom. During this period the U.S. stock market fell approximately by 56 per cent.[25] Respectively, it can be said that the GFC started from the collapse of Lehman Brothers and the crisis spread to developed and emerging markets, Europe being part of it. Consequently, the stock market crash in the U.S. affected stock and bond markets in the EU. According to results of the G5 countries in Hartmann *et al.*'s (2004) study the stock market crashes happen about once, and bond market crashes approximately twice in a human lifetime. In the study the authors have defined the stock market crash as a 20% weekly price loss and a bond market crash as an 8% weekly price loss in the prices.[26] Based on the study by Hartmann *et al.* (2004), the definition of stock market crash in this paper is hold to be a 20% price loss within a week interval and bond market crash as an 8% weekly price loss.

2.2.3. Contagion

Dornbusch *et al.* (2000) define contagion as a significant increase in cross-market linkages after a shock that affects an individual country or specific country groups that can be measured by the level of asset price or financial flow co-movements across markets relative to co-movement

[24] Brooks, Chris. *Introductory Econometrics for Finance*. 3rd ed. N.p.: Cambridge UP, 2014. Print. p. 353
[25] Meric *et al*. 2012, p. 45
[26] Hartmann, P., S. Straetmans, and C. G. De Vries. "Asset Market Linkages in Crisis Periods." *ECB Working Paper No. 71* (2001). p.6

in steady time periods.[27] A significant increase in cross-market linkages after market turmoil would characterize contagion and, on the other hand, an insignificant increase states for interdependence. In previous studies, contagion has been defined in several ways depending on the type of study. According to Baur & Lucey (2008), the cross-asset contagion of stock-bond linkages can be described as a significant increase in the correlation coefficient where a comparison is made between the market turmoil (the GFC and the EZDC) and a benchmarked period that has a positive correlation level. Even if the correlation change is positive when the level is in a negative correlation regime, it can be stated that contagion is inconsistent since the movement of stocks-bonds is not the same direction.[28] For instance, Bauer & Lucey (2008) argue that "if the stock–bond correlation changes from −0.5 to −0.25 there is a positive correlation change but no contagion since stocks and bonds do not co-move."[29] Subsequently, the paper attempts to study whether an increased correlation *i.e.* contagion exists by looking at the correlation coefficient which appears as a relative measurement (in a scale between -1 and 1) for tracking co-movement of stock asset returns. When the movement suggests a perfect correlation, asset returns move in unison. *Vice versa*, if the movement is exactly the opposite (-1) between assets, a perfect negative correlation exists.

The relevant literature to this paper consists of financial contagion in terms of stock and bond markets (Dua & Tuteja, 2014; Forbes, K. & Rigobon, R., 2002; Hartmann *et al*., 2004; Gravelle *et al*., 2006 and Longstaff, 2010) and effects of contagion across multiple assets (Aditya & Boschi., 2004; Büttner & Hayo 2010). The paper intends to seek if contagion exists in the equity indices of Germany, France, the United Kingdom, Italy and Spain in terms of co-movements between stock and bond markets. The study by Hartmann *et al.* (2004) addresses that nonetheless the phenomenon of contagion is common after a common shock, it is not prevalent among the G5 (the U.S., Japan, the United Kingdom, Germany and France) countries due to the level of spill-over probabilities in absolute terms that hardly exceeds 20% in his study.[30] However, Forbes (2013) argues that compared to other economies, the countries in the Eurozone have increased more rapidly in regards to a variety of factors that are linking the countries through trade and banking. Therefore, this indicates that interdependence and

[27] Dornbusch, R., Y.C. Park and S. Claessens (2000), Contagion: Understanding How it Spreads, The World Bank Research Observer, Vol. 15, 177-197 p.177
[28] Baur, Dirk G., and Brian M. Lucey. "Flights and Contagion—An Empirical Analysis of Stock–bond Correlations." Journal of Financial Stability 5.4 (2008): 339-52. Web. 12 Apr. 2015. p.341
[29] Baur & Lucey, 2008, p.341
[30] Hartmann *et al.*, 2004, p. 321

contagion in the Eurozone, as well as contagion from the Eurozone to other areas should be expected.[31] Furthermore, Forbes & Rigobon (2012) address that during periods of stability where two markets are moderately correlated, a shock to one market has ripple effects on the other market and thus, it also has a significant incremental effect in market co-movement, which constitutes contagion.[32] However, if the increase in correlation is not significant even though there is a strong level of market co-movement that is a base for strong linkages between two or more economies, it rises the phenomenon of 'interdependence'.[33] In this situation contagion implies that cross-market linkages are fundamentally distinct after a shock occurs in one market, while interdependence is a definition for no significant change in cross-market relationships.[34]

Thus, it is relevant to study whether Hartmann *et al.*'s (2004) study holds true when considering the impact of the GFC and the EZDC within the five largest economies in the EU. The importance of studying financial contagion is based on two factors. First, the macroeconomic perspective considers the legislation of fiscal and monetary policies that becomes easier when the mechanisms of the impacts of financial shocks are known. Second, it is vital to understand the relationship between two or more assets and whether it is stable in terms of planning diversification strategies from the investment management perspective.[35]

2.2.4. Flight-to-quality and Flight-from-quality

Papavassiliou (2014) states that flight-to-quality refers to a situation that occurs during the times of increased stock market uncertainty which leads to increases in the prices of government bonds in a relation to stocks, and simultaneously the co-movement based returns between two asset classes become less positively correlated. Thus, meaning that investors tend to purchase safer assets *e.g.* treasury bills and sell high-risk investments due to a period of market turmoil. According to Baur & Lucey (2009), the investors who hold assets that consist of both stocks and bonds are less likely to suffer from co-movements of stocks and bonds during a financial

[31] Papavassiliou, Vassilios G. "Financial contagion during the European sovereign debt crisis: A selective literature review." *Crisis Observatory, ELIAMEP, Hellenic Foundation for European & Foreign Policy, Research Paper 11* (2014). p.12
[32] Forbes K, Rigobon R. 2002, p.1
[33] Forbes K, Rigobon R. 2002. p.1
[34] Forbes K, Rigobon R. 2002. p.1
[35] Papavassiliou, 2014, p.14

turmoil.[36] Hence, it implies that flights that cover both flight-to-quality from stocks to bonds and flight-from-quality from bonds to stocks have an impact on the financial systems by possibly increasing the resiliency and stability and simultaneously reducing the losses that investors suffer in the periods of crises.[37]

Flight-to-quality has been studied less extensively than contagion in previous literature. However, some of the existing literature count the relationship between stocks and bonds (*e.g*. Baur & Lucey, 2008; Connolly *et al*., 2005; Chiang *et al.*, 2007 and Papavassiliou, 2014), correlations between stocks and bonds and the distinction between flight-to-quality and cross-asset contagion (Gonzalo & Olmo, 2005) and correlations between stock-bond returns in crisis times (Hartmann *et al.*, 2001). Nonetheless, empirical studies of return correlations between stocks and bonds in crisis times are relatively limited in comparison to the contagion literature. The study conducted by Hartmann *et al.* (2004) defines flight-to-quality phenomenon as the probability that a bond market booms, when a stock market crashes.[38] As a result of the study, Hartmann *et al.* (2004) state that the national borders do not have an effect in terms of limiting the degree of contagion or flight-to-quality, which again, illustrates a possible disadvantage of international financial market integration from the viewpoint of domestic financial market stability.[39] Thus, the paper intends to study the possible existence of flight-to-quality from stocks to bonds, which is indicated as a significant decrease in the correlation coefficient. A positive correlation between stocks and bonds during the pre-crisis period which turns to be negative during the GFC indicates that there is flight-to-quality. According to Baur & Lucey (2008), flight-to-quality can also be spotted by a negative stock–bond correlation degree in the pre-crisis period and a significant negative change in the crisis period.[40] Furthermore they note that, flight-from-quality from bonds to stocks is also measured with a significant decrease in the correlation coefficient.[41] The difference between flight-from-quality and flight-to-quality is that in flight-from-quality the correlation change exists in a bond market crisis.

It is also notable that contagion and flights are considered to be mutually exclusive effects in terms of cross-asset linkages meaning that in a case of flight-to-quality from stocks to bonds,

[36] Baur & Lucey, 2008, p.340
[37] Baur & Lucey, 2008, p.340
[38] Hartmann *et al*., 2004, p.321
[39] Hartmann *et al*., 2004, p.323
[40] Baur & Lucey, 2008, p.341
[41] Baur &Lucey, 2008, p.341

cross-asset contagion between stocks and bonds cannot exist.[42] Likewise, if stock–bond contagion exists, there cannot be flight-from-quality. Table 1 captured from Baur & Lucey's (2008) article offers an overview for possible circumstances of possible market movements and coefficient correlations and how it affects contagion, flight-to-quality and flight-from-quality. However, this table describes a univariate analysis *i.e*. when individual countries are considered and hence, excluding cross-country linkages.

Table 1: Overview flight-to-quality, flight-from-quality and stock–bond contagion[43]

	Negative change of stock-bond correlations and negative correlation level	***Positive change of stock-bond correlations and positive correlation level***
Stock markets falling	*Flight-to-quality from stocks to bonds*	*(Negative) Contagion*
Stock markets rising	*Flight-from-quality from bonds to stocks*	*(Positive) Contagion*
Bond markets falling	*Flight-from-quality from bonds to stocks*	*(Negative) Contagion*
Stock markets rising	*Flight-to-quality from stocks to bonds*	*(Positive) Contagion*

Note: Table 1 summarizes different possible scenarios for the phenomena of flight-to-quality, flight-from-quality and contagion with the application to distinct market circumstances. The correlations of stock-bond are divided into two categories by the level of correlation that is either negative or positive.

2.2.5. Analysis Models in Previous Literature

This part of the paper consists of the analytical models used in the previous literature in order to study the phenomena of asset returns and co-movements of different asset classes and therefore, this section covers the relevant methods including the study method by Hartmann *et al.* (2001).

Autoregressive Conditional Heteroskedasticity (ARCH)

The analysis models in previous literature are mainly consisting of different forms of simple cross-country correlation analysis which are based on either simple regression models or as in most of the cases, different variations of the ARCH model (*e.g.* King & Wadhwani, 1990;

[42] Baur & Lucey, 2008, p.341
[43] Baur & Lucey, 2008, p.342

Hamao *et al.*, 1990; Malliaris & Urrutia, 1992; Lin *et al.*, 1994; Susmel & Engle, 1994; Bartram, 2007).

The Autoregressive Conditional Heteroskedasticity model is a time series model for volatilities. The term heteroskedasticity means that the variance of the errors is not constant (var (u_t)). The usage of ARCH model instead of a simple regression analysis has an advantage in that first, it can capture non-linear relationships and second, it can capture the time varying volatility.[44] Another reason to use the ARCH model when studying financial asset returns is its characteristic of volatility clustering. The phenomenon of volatility clustering refers to "the tendency of large changes in asset prices (of either sign) to follow large changes and small changes (of either sign) to follow small changes."[45] However, Hartmann *et al.* (2004) criticize the usage of conditional correlation analysis for its limitation to only provide results about the amount of correlation in the data under observation. They argue that studying the probabilities of the occurrences has a "more direct economic meaning."[46] However, the authors do not necessarily mean to minimize the importance of the correlation measures, rather think of it as an intermediate step in the process of obtaining a measure to study for instance the likelihood of a crash spill-over.[47] Another criticism in the usage of ARCH type models, according to Hartmann *et al.* (2001), lies in its quality to be predisposed towards the multivariate normal distribution which tends to underestimate the frequency of spill-overs.[48]

Statistical Extreme Value Analysis

As noted above in this paper Hartmann *et al.* (2001) argue that the ARCH-based types of analysis do not necessarily explain the phenomenon under investigation in their article. Therefore, they have developed their own model to capture the linkages between international asset classes. To study the crisis linkages between different security markets, they start by considering the Dumas' (1994) presentation of the International CAPM (ICAPM).[49] The authors note that "the systematic part of the ICAPM generates [either positive or negative

[44] Brooks, 2014, p.416 and 424-425
[45] Brooks, 2014, p.423
[46] Hartmann *et al.*, 2004, p.313
[47] Hartmann *et al.*, 2001, p. 8
[48] Hartmann *et al.*, 2001, p.8
[49] Hartmann *et al.*, 2001, p.10

depending of the sign of the risk factor] linkages between different local asset markets."[50] Therefore, considering Dumas' ICAPM the authors can spot the possible phenomenon of flight-to-quality. The ICAPM also captures the sequential movement of asset classes that might occur due to contagion.

To capture the extreme linkages Hartmann *et al.* (2001) use probability theory with a conditional expectation as the extreme linkage indicator. And to test whether it is the phenomenon of contagion that dominates the phenomenon of flight-to-quality or the other way around, the authors use Z-statistic:

$$Z=\frac{l_{CO}(k_1) - l_{FTQ}\,(k_2)}{\sigma[l_{CO}(k_1) - l_{FTQ}\,(k_2)]} \qquad (1)$$

,where CO refers to stock and bond co-crashes and FTQ to the phenomenon of flight-to-quality.

However, the method described above is merely a brief summary of the method and in case the reader wishes to get an exhaustive description of the statistical dimensions, is he or she advised to see the 2001 publication from Hartmann *et al.*

3. Research Design

The purpose of this paper is to study cross-asset linkages for stock and bond markets before and after the financial distress in the EU (GB, DE, FR, IT and ES). Previous literature suggests that asset returns tend to co-move more strongly during market turmoil. The results of Hartmann *et al.*'s (2004) study show that the probabilities of the occurrence of cross-asset contagion are approximately the same as the occurrence of the phenomenon of flight-to-quality. In addition, cross-country linkages show similar results to national linkages which can be interpreted as a disadvantage to international financial integration.[51] Thus, the purpose of this study is to cover a gap in the existing literature by studying the effects of the GFC to cross-asset linkages and

[50] Hartmann *et al.*, 2001, p.10
[51] Hartmann *et al.*, 2004, p.313

co-movements of these assets and simultaneously contributing to the field of asset pricing in finance.

Moreover, the research design of this paper is classified as a case study, which is defined as an empirical analysis examining extensively a contemporary phenomenon within the actual context.[52] The strength of a case study -design lies in its ability to study a phenomenon and scrutinize it in a contemporary context which depicts the characteristics of the study. Thus, the phenomenon of GFC and its effects to stock and bond markets are studied in a relation to understand *'how'* the tendencies of asset co-movements have changed over the crisis period.

3.1. Scientific Perspective

The scientific perspective of the study is grounded from natural sciences since the field that the paper contributes is finance. Thus, the epistemological assumptions underlying this study are based on positivism and the ontological assumptions, on the other hand, on objectivism. As Bryman & Bell (2011) note, the positivist approach is frequently associated with the deductive approach.[53] Hence, positivism is additionally consistent with the relation to theory testing as the study is using a deductive approach *i.e.* testing the hypothesis derived from Hartmann *et al.* (2004) and Forbes (2013) with the contemporary data set.

3.2. Empirical Material

The empirical material is gathered from the market indices (stocks and bonds) for the five largest economies in the EU, *(Germany (DAX 30), France (CAC 40), United Kingdom (FTSE 100 Index), Italy (FTSE MIB) and Spain (IBEX 35*), which are J.P. Morgan's price indices downloaded from Thomson Reuters Datastream. As for bond markets, the data consists of all-traded 1-10 yr. government bonds that correspond with the price indices of stock markets for each country. This is the same type of data Hartmann *et al.* (2004) (their study used Financial

[52] Farquhar, Jillian Dawes (2012), Case Study Research for Business. London: Sage. p.6
[53] Bryman, Alan, and Emma Bell. *Business research methods 3e*. Oxford university press, 2011. p.20

Times/Standard & Poor's world price indices) use in their study on where corporate bond indices are excluded due to the emphasis on flight-to-quality phenomenon.[54] As in the study by Hartmann *et al.* (2004), the price data (gathered weekly from Friday to Friday in the countries' own currency) has been calculated to returns by using the logarithmic price differences. The authors note that the stock returns are not compensated for dividends and neither are bond returns for coupon payments.[55] Thus, the same application holds in this study in terms of processing with raw data that consists of 366 weekly observations from December 30, 2005 to December 28, 2012. Thus, the time series data has been arranged in chronological order from the earliest data point (30 Dec. 2005) to the latest data point (28 Dec. 2012). This order is necessary for the tests and estimation methods (*e.g.* the Durbin-Watson test[56]) to give valid results.

Hartmann *et al.* (2004) argue behalf of weekly conducted data having the advantage of diminishing the time zone differences and hence, reducing a possible bias that may rise in daily frequency used data. Furthermore, the advocacy of weekly used data is better to study a phenomenon such as the market crash *i.e.* the impact of the GFC. Nonetheless, Hartmann *et al.* (2004) state the limitation of the chosen data input frequency, which is "the cost of not being able to address explicitly intraday or daily short-run dynamics that could also help to understand crisis propagation mechanisms."[57]

The time period of 2006-2012 contains the GFC and the EZDC which are the base for studying cross-asset linkages during a period of crisis in this study. The analyzed data starts from 2006 which is the period when the economy was still on the boost, and before the GFC of 2007-2008. The last observation that is included in the data is in December 2012 based on a diminished degree of contagion in October 2012 for the other Eurozone countries.[58] This is due to carefully implemented reforms and accomplished fiscal consolidation within the countries that had the risk of default. Consequently, the paper addresses the impact of the GFC on stock and bond markets and therefore, the chosen data covers a relevant time period.

[54] Hartmann *et al*., 2004, p.326
[55] Hartmann *et al*., 2004, p.326
[56] See chapter 4.1.4.
[57] Hartmann *et al*., 2004, p.326
[58] "Long-term Interest Rate Statistics for EU Member States." ECB: Long-term Interest Rates.

As discussed earlier in the second chapter, Hartmann *et al.* (2004) define a stock market crash as a 20% weekly price loss and a bond market crash as an 8% weekly price loss. The gathered data from the time period of 2006-2012 indicates that a crash in the stock markets occurs on October 10, 2008 (see table 2). Regressions are constructed annually in order to study the correlation coefficient changes due to the inability of OLS to capture time varying correlations. However, when using OLS to study regressions and correlations, tests for autocorrelation and heteroskedasticity need to be performed which are conducted using Durbin-Watson and Breusch-Pagan tests respectively.

Hence, annual correlation coefficients have been generated using OLS to determine how it changes prior to and after market crashes. However, the studied time period does not contain a bond market crash in any of the studied countries due to the fact that the highest weekly price loss is -3,28% in Spain on July 20, 2012. Thus, the study seeks to answer whether flight-to-quality exists rather than flight-from-quality. In addition, in terms of studying contagion in a cross-country analysis with the OLS method, the data is gathered from the time period of 2006-2010 based on the fact that it contains both steps of a business cycle; *boom* and *bust.* Similar to the flight-to-quality study's characteristics, contagion is studied annually between 2006 and 2010 across the five countries. The currency issue with the United Kingdom is also considered in terms of studying contagion, hence, Pounds (£) are converted into Euros (€) with the exchange rate downloaded from Thomson Reuters Datastream. The exchange rate is also based on a weekly interval data which is used to convert FTSE 100 stock prices.

Table 2: Stock market price falls in the five EU countries in October, 2008

Date	FTSE 100 (GB) £	Change in %	CAC 40 (FR) €	Change in %	DAX 30 (DE) €	Change in %	MIB (IT) €	Change in %	IBEX 35 (ES) €	Change in %
26.9.2008	5088,4		4163,3		6063,5		27154,3		11387,9	
3.10.2008	4980,2	-0,021	4080,7	-0,020	5797,0	-0,044	25910,5	-0,049	11418,5	0,003
10.10.2008	3932,0	**-0,211**	3176,4	**-0,222**	4544,3	**-0,216**	20308,8	**-0,216**	8997,7	**-0,212**
17.10.2008	4063,0	0,0333	3329,9	0,0483	4781,3	0,052	21644,5	0,066	9655,2	0,073
24.10.2008	3883,3	-0,044	3193,7	-0,041	4295,6	-0,102	19900,3	-0,081	8353,2	-0,135
31.10.2008	4377,3	0,1272	3487,0	0,092	4987,9	0,161	21375,7	0,074	9116	0,091

Note: Table 2 comprises the stock market price falls in the five countries: the United Kingdom, France, Germany, Spain and Italy. The results show that each market crashes during the week 3-10.10.2008 with more than a -20% price fall and hence, the crash can be considered to be a Global stock market crash.

3.3. Method

This chapter introduces the analysis method, Ordinary Least Squares (OLS), used to answer the research questions. A brief statistical explanation is provided of how this method is utilized. OLS as a simple regression model is utilized in order to study (1) cross-asset linkages and later (2) cross-country linkages for stock markets. OLS is recognized to be the Best Linear Unbiased Estimator (BLUE) that covers numerous desirable features which are addressed below.

3.3.1. Ordinary Least Squares (OLS)

Regression analysis examines the relationship between variables and Ordinary Least Squares method is a general model used to construct regressions. The *y* variables are assumed to be 'stochastic' which indicates the data to have a probability distribution. *Vice versa*, the *x* variable is considered as a fixed ('non-stochastic') value in repeated samples.[59] In this study, stock market log-returns are characterized as *y* variables and bond market log-returns as *x* variables in order to measure flight-to-quality in cross-asset analysis where 35 regression models are generated. Subsequently, when building a regression model for cross-country analysis, each country (making it 100 regression models in total) is taking its turn to be the *x* and *y* variable *(GB-FR, GB-DE, GB-IT, GB-ES, FR-GB, DE-GB, IT-GB, ES-GB, FR-DE, FR-IT, FR-ES, DE-FR, IT-FR, ES-FR, DE-IT, DE-ES, IT-DE, ES-DE ES-IT and IT-ES*). In this way, it can be seen if contagion is bi-directional or not. Since linearity is a requirement for the regression model in OLS method, it means that the relationship between *x* and *y* variables has to be able to be drawn diagrammatically with a straight line that is the best fitted line estimated by minimizing the total sum of least squares.

The OLS method is considered to be BLUE as discussed earlier in this chapter which repeatedly stands for the Best Linear Unbiased Estimator. *'Best'* refers that the estimator has the minimum variance among all linear unbiased estimators; *'Linear'* that the estimators are linear; *'Unbiased'* the actual values of parameters are their true values; and *'Estimator'* that parameters can be considered to be true values.[60]

[59] Brooks, 2014, p. 76
[60] Brooks, 2014, p. 91

By using this model, the relationship between stock and bond markets (*i.e.* the cross-asset linkages) is studied annually (2006-2012) in order to measure (1) flight-to-quality and contagion across assets in national markets and (2) subsequently expanding it to a cross-country analysis and study whether contagion exists within the five EU countries' stock markets. In latter case, the study period is 2006-2010 based on the business cycle.

The study measures flight-to-quality and contagion effects across assets in national markets and it has 50-51 observations for each year based on the interval level of data that is based on weekly observations. In this study, the prices of stocks and bonds are converted into returns (%) by computing the log differences in the chosen indices, on a weekly basis (see equation 2).

$$(\text{Ln } I_t/I_{t-1}) \qquad (2)$$

From these returns, scatter plots are formed and regression lines added in order to see if the relationship is positive or negative. The equation

$$\hat{y} = \hat{\alpha} + \hat{\beta}x + \varepsilon \qquad (3)$$

,and R^2 are derived from each of the regression lines. Furthermore, the regression model refers to the following model that analyses the relationship between stock and bond markets:

$$Stock\ market_j = \alpha + \beta_1 (Bond\ market)_j + e_j \qquad (4)$$

,where the dependent variable *Stock market*$_j$ is a measure of co-movement that consist of the relationship with the independent variable *Bond market*$_j$. For the cross-country analysis the regression model studies the relationship between two stock markets:

$$Stock\ market_j = \alpha + \beta_1 (Stock\ market)_i + e_{ji} \qquad (5)$$

,where the dependent variable *Stock market*$_j$ is a measure of co-movement that consist of the relationship with the independent variable *Stock market*$_i$ where *i* refers to another country's market. Furthermore, correlation coefficients (*r*) are studied in order to capture flight-to-quality and contagion.

3.3.2. Hypothesis Testing

The degrees of freedom (*df*) are 50 or 51 depending on how many weekly observations a year has in the cross-asset and cross-country analyses. The test of significance can be scrutinized in order to examine the significance level, which is calculated with the equation (5) below. By looking at the *t*-table[61] for two tailed test of significance, a critical value of 2.009 is obtained for *df* of 50 and significance level of 0,05. In the cross-country analysis the *df* and the critical value remain the same based on the amount of observations.

$$t - test: \frac{\widehat{\beta}}{SE(\widehat{\beta})} \qquad (5)$$

In addition, the null hypothesis is a crucial factor to study the significance of the studies and the null hypothesis and the alternative hypothesis will be the following:

$$H_0: \beta=0 \text{ and } H_1: \beta\neq0 \qquad (6)$$

Thus, if the null hypothesis is rejected it can be stated that the value of beta generated from the analysis is statistically significant. The test of significance approach calculating the test statistics and the *p*-value has been used to determine that the results are statistically significant.

The significance level of null hypothesis used in this study is 5% which states that if the null hypothesis is rejected at this level, the results are statistically significant. *Vice versa*, if the null hypothesis is not rejected at the level of 5% they are insignificant. In addition, *p*-value is scrutinized since it is often referred to "the probability of being wrong when the null hypothesis is rejected."[62] In this study the used *p*-value is 5% that is also equivalent to the rejection level of null hypothesis. A *p*-value that is more than 0.05 thus, states that there is a possibility that the null hypothesis is rejected incorrectly. According to Brooks (2014), "the *p*-value [is] termed the plausibility' of the null hypothesis; so, the smaller the *p*-value, the less plausible is the null hypothesis."[63]

[61] "M419 AP Statistics Formula and Distribution Sheets." Statistics Formulas and Distribution Tables. <http://www.fhs.d211.org/departments/math/kclindaniel/apstats/formulas.html>
[62] Brooks, 2014, p. 121
[63] Brooks, 2014, p.121

The null hypothesis was tested for each regression in each year individually making it 35 observations for the cross asset analysis and additional 100 observations for the cross country analysis. To summarize the results the test proved that in 2 out of the 100 observations in the cross-country analysis, the null-hypothesis could not be rejected and thus, the results were insignificant: GB-FR in 2009 and FR-IT in 2007. In the cross-asset analysis 11 out of 35 observations resulted to be insignificant. These observations included all the regressions made in 2006; 2008 and 2009 regressions for Italy and Spain and 2011 and 2012 regressions for France. However, the remaining 122 regression analysis proved to be statistically significant.

3.3.3. Dickey-Fuller Test

Prior to the actual regression analysis, a unit root testing of the data was conducted using the Dickey-Fuller test in Microsoft Excel. Testing that the data is stationary is relevant considering the way the variables are treated since non-stationary data can strongly influence the behavior properties of the data.[64] A stationary data series includes a constant mean, constant variance and constant autocovariance for each lag, whereas non-stationary data has a mean, variance and autocovariance that change over time.[65] Thus, using non-stationary data can lead to spurious regressions and false interpretations.[66] In addition, in case of non-stationary data, "it can be proved that the standard assumptions for asymptotic analysis will not be valid."[67] Therefore, non-stationary data includes some major drawbacks considering the reliability of the analysis and thus, by proving with the use of a Dickey-Fuller test that the data is stationary, the reliability increases considering the results of this research. The significance level of in the study was set to 95% and thus by looking at the *p*-values one can see if the data is stationary or not. Thus, *p*-values below 0.05 prove that the data return series are stationary. From the Dickey-Fuller test one can see that the data is stationary ($p - values_{1-10} < 0{,}05$). Table 3 indicates that the market returns for each country are stationary.

[64] Brooks, 2014, p.353
[65] Brooks, 2014, p.353
[66] Brooks, 2014, p.354
[67] Brooks, 2014, p.354

Table 3: Dickey Fuller test for bond and stock market ret. % for each country

Test (sig. level of 5% for *p*-value)	GB (£)		GB (€)	FR (€)		DE (€)		IT (€)		ES (€)	
	Stock	*Bond*	*Stock*	*Stock*	*Bond*	*Stock*	*Bond*	*Stock*	*Bond*	*Stock*	*Bond*
ADF											
No constant*	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	0,3%	0,1%	0,1%
	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	0,3%	0,1%	0,1%	
Const-Only	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	0,5%	0,1%	0,1%
Const + Trend*	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
Const+Trend+Trend^2*	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
Stationary*	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
**	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
***	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
****	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE

Note: Table 3 depicts the results of the ADF (Augmented Dickey Fuller) –test by stating that the stock and bond returns are stationary with a p-value of ≤0,5% with different applications in terms of const., and trend.

3.3.4. The Durbin-Watson Test

In order to proceed with the OLS regression model, autocorrelation of the errors need to be checked, especially when using time series data, since a possible autocorrelation indicates a violation of the regression assumptions *i.e.* BLUE is not fulfilled. [68] Thus, the assumption of OLS is that the errors are uncorrelated and one way to test autocorrelation of the error terms is to use the Durbin-Watson test. The standardized residuals are the key in order to identify possible autocorrelation, since time ordering data might have a possible cyclical behavior. According to Simonof (2015), the Durbin–Watson (DW) test can be classified as a highly parametric test for autocorrelation.[69]

[68] Simonof, Jeffrey S. "Ordinary Least Squares Estimation and Time Series Data." 2015. p.3 <http://people.stern.nyu.edu/jsimonof/classes/2301/pdf/regtime.pdf>
[69] Simonof, 2015 p.3

The following equation shows how *d* (*i.e.* DW) values are calculated:

$$d = \frac{\sum_{t=2}^{T} (e_t - e_{t-1})^2}{\sum_{t=1}^{T} e_t^2} \qquad (6)$$

Hence, by starting off with the data also used in OLS where residuals (*e*) and the squares of residuals (e_i^2) are computed. In order to calculate the Durbin-Watson test, $(e_i - e_{i-1})^2$ is computed and the sum of $(e_i - e_{i-1})^2$ is divided by the sum of (e_i^2) observations and thus, giving the *d* value. The DW statistics always give a value that is between 0 and 4.[70] Values close to 2 denote that there is no autocorrelation in the sample. Additionally, close to 0 indicate a positive autocorrelation and values close to 4 *vice versa*.[71] Thus, the study has included the values close to 2 as stating there is no autocorrelation.

The DW test was performed for all the generated regressions for cross-asset and cross-country analyses separately making it 135 DW tests in total. Out of 135 tests, only 9 DW results were categorized for having a tendency for autocorrelation, which however, cannot be classified strong.[72]

3.3.5. The Breusch-Pagan Test

The drawback of the OLS regression model is that it only generates the relationship between the independent and dependent variable assuming that the residuals follow a standard normal distribution and thus, that the errors have a constant variance (*i.e.* the errors are homoskedastic). Hence, it is vital, concerning the reliability of the results, to perform a test to see whether heteroskedasticity is present. However, if OLS is used despite the presence of heteroskedasticity, it is plausible that the standard errors are wrong and thus, the rejection of

[70] Brooks, 2014, p.196
[71] Brooks, 2014, p.196
[72] For more detailed analysis see Appendix, Tables 1 and 2.

the null hypothesis might have been made with wrong grounds. Therefore, this may lead to inferences that are misleading.[73]

The Breusch-Pagan Test, like the Durbin-Watson test, was performed to each of the regression analyses (both cross-asset and cross country) making it 135 observations in total to see whether heteroskedasticity is present. First, the least squares residuals were generated from the regression models and then the squared residuals e_i^2 were calculated from them. The new regression using the squared returns as the dependent variable and the original independent variable generated the *p*-value for F-statistics. If this value is smaller than the 0.05 significance level, it means that the H_0 of homoskedastic error (H_0: $\theta = 0$) could be rejected and thus, that the alternative hypothesis H_1: the error terms are heteroskedastic, holds.

Out of the 135 regression time data series 13 were found to be heteroskedastic. To correct these errors, 'robust' (*i.e.* heteroskedasticity-consistent) standard errors have been used in these particular regressions and the rejection of the null-hypothesis was confirmed using the robust standard errors, to increase the significance of the results. "The effect of using the correction is that, if the variance of the errors is positively related to the square of an explanatory variable, the standard errors for the slope coefficients are increased relative to the usual OLS standard errors, which would make hypothesis testing more 'conservative', so that more evidence would be required against the null hypothesis before it would be rejected."[74]

4. Analysis

This chapter represents the findings from the regressions constructed using the OLS method. The data is analyzed in two categories (cross-asset and cross-country) keeping four crucial aspects in mind. First, it is proved that all the returns are stationary. Second and third, by conducting the Durbin-Watson test and the Breusch-Pagan test, the data consisting autocorrelation or heteroskedasticity has been identified and the robust standard errors have

[73] Brooks, 2014, p.185
[74] Brooks, 2014, p.186

been used to derive statistically significant results. Lastly, the test for null-hypothesis was conducted to rule out the statistically insignificant results from the analysis. Keeping these four things in mind the next subtitles divide the results from the data into cross-asset and cross-country results considering the two most important concepts introduced in chapter 2: contagion and flight-to-quality by looking at the correlation coefficients from the analysis.

4.1. Cross-Asset Linkages

This chapter describes the results from the cross-asset analysis by introducing each of the five countries separately. The most significant results were gathered from the United Kingdom, Germany and France. In the case of the United Kingdom the results showed no significant change in non-crisis period compared to the start of the GFC. In the case of Germany, the phenomenon of Flight-to-Quality was spotted whereas; the case of France showed some effects of contagion.

4.1.1. The United Kingdom

In the United Kingdom, the correlation coefficient has more or less stayed the same during years of 2007-2010 indicating that the shocks in the stock markets have not had much impact on the co-movements of the asset classes. Nevertheless, there is a slight decrease in the correlation coefficient from 2008 (-0,32) to 2009 (-0,44) where the regression's downward slope indicates that the phenomenon of flight-to-quality might exist and thus, the shock in the stock markets has generated an increase in the United Kingdom's government bond market returns. Moreover, a significant decrease in correlation coefficients from the year 2010 (-0,33) to years 2011 (-0,51) and 2012 (-0,62) represents an unusual flight-to-quality phenomenon since the previous literature suggests that the assets tend to co-move more strongly during the periods of crises and the period of 2011 and 2012 can be considered more as market recovery.

Table 4. Correlation coefficients for the United Kingdom

Year	*Coef.*	*t*	*p*
2006	-0,060	-0,518	0,607
2007	-0,391***	-2,989	0,004
2008	-0,324**	-2,383	0,021
2009	-0,436***	-3,400	0,001
2010	-0,333**	-2,407	0,020
2011	-0,509***	-4,170	0,000
2012	-0,618***	-5,448	0,000

*Note: *,** and *** refer to statistical significance at the 10%, 5% and 1% levels, respectively.* [75]

4.1.2. Germany

The results from Germany show a significant decrease in the correlation coefficient from 2008 to 2009 (a decrease from -0,38 in 2008 to -0,53 in 2009 and -0,60 in 2010). This supports the argument from previous literature that the assets tend to co-move more strongly during the periods of market turmoil since this is the time period when the markets crashed in Europe due to the GFC. Since the slope of this correlation is negative it can be further interpreted that the co-movement is in the form of flight-to-quality. Thus a crash in stock markets has led to a boom in the government bond markets in Germany making the investors prefer purchasing more safely classified government bonds rather than assets in the stock market, thus utilizing diversification of the unsystematic risk in their portfolios. It is also worth noting that the correlation coefficient stays between -0,52 and -0,60 through the whole observation period after 2009 which indicates that the co-movement trend has continued to follow the pattern of flight-to-quality until 2012.

Table 5. Correlation coefficients for Germany

Year	*Coef.*	*t*	*p*
2006	-0,101	-0,901	0,372
2007	-0,518***	-4,158	0,000
2008	-0,378***	-2,830	0,007
2009	-0,531****	-4,356	0,000
2010	-0,596***	-5,181	0,000
2011	-0,522***	-4,226	0,000
2012	-0,579***	-5,051	0,000

*Note: *,** and *** refer to statistical significance at the 10%, 5% and 1% levels, respectively.*

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[75] For more comprehensive tables, see appendix 1.

4.1.3. France

The results from France tend to show a little different outcomes than the two previous regressions (GB and DE). Between 2007 and 2008 the correlation coefficient actually drops from 0,52 in 2007 to 0,34 in 2008 which indicates less co-movement between the two asset classes. However, the correlation coefficient does increase slightly again in 2009 to 0,38 and continues to increase in 2010 having the value of 0,47. Hence, if 2009 is considered as the start of the GFC in Europe, it can be seen that due to the crisis the correlation has increased between the two asset classes in France. A noteworthy point here is that in contrast to the other cases above, the results from France show a positive slope in the correlation equation. Thus, the phenomenon of contagion can be spotted to occur where a shock in the stock markets tend to spill-over to the bond markets.

Table 6. Correlation coefficients for France

Year	*Coef.*	*t*	*p*
2006	0,141	-0,518	0,324
2007	0,518***	-2,989	0,000
2008	0,345**	-2,383	0,013
2009	0,380***	-3,400	0,006
2010	0,469***	-2,407	0,003
2011	0,141	-4,170	0,242
2012	-0,213	-5,448	0,133

*Note: *,** and *** refer to statistical significance at the 10%, 5% and 1% levels, respectively.*

4.1.4. Spain

In the case of Spain the null-hypothesis could not be rejected for the years 2006 and 2009. However, one aspect worth noting is that the slope of the regression turns from negative (2008) to positive (2010-2012) indicating that there is a tendency of the asset co-movements turning from the phenomenon of flight-to-quality to contagion. In addition, the correlation coefficient has increased significantly from 2007 (-0,41) to 2012 (0,60). Hence, there is a point where the crash has started to spill over to the bond markets in Spain. Nevertheless, the correlation still remains to be negative in 2008, which states that the spill-over effect has happened after the year 2008.

Table 7. Correlation coefficients for Spain

Year	*Coef.*	*t*	*p*
2006	0,135	-0,941	0,352
2007	-0,412***	-3,137	0,003
2008	-0,262*	-1,877	0,067
2009	-0,103	-0,712	0,480
2010	0,533***	3,095	0,002
2011	0,383**	2,259	0,024
2012	0,602	5,219	0,000

*Note: *,** and *** refer to statistical significance at the 10%, 5% and 1% levels, respectively.*

4.1.5. Italy

The results from Italy show a similar pattern to the results generated in Spain's case. Again here, the years 2006, 2008-2009 show statistically insignificant results due to the fact that the null-hypothesis could not be rejected. The correlation coefficient shows a slight change in absolute values during the observation period (-0,58 in 2007 and 0,65 in 2012). This indicates that the two asset classes are slightly affected and hence, the flight-to-quality phenomenon turns to contagion during the GFC. Consequently, due to the spill-over effects from stocks to bonds, investors do not seek to purchase government bonds instead of assets in the stock market. However, as in the case of Spain it can be seen that the slope of the regression changes from negative to positive indicating that during 2010-2012 the asset classes have co-moved in the same direction including contagion effects.

Table 8. Correlation coefficients for Italy

Year	*Coef.*	*t*	*p*
2006	-0,087	-0,876	0,385
2007	-0,575***	-4,926	0,000
2008	-0,126	-0,891	0,377
2009	-0,008	-0,055	0,956
2010	0,606***	5,393	0,000
2011	0,463***	3,652	0,001
2012	0,653***	6,038	0,000

*Note: *,** and *** refer to statistical significance at the 10%, 5% and 1% levels, respectively.*

4.2. Cross-Country Linkages and the Bi-directional Contagion

Generally, looking at the results from the cross-country analysis it can be spotted that all the linkages show bi-directional contagion (having a positive correlation coefficient) effects throughout the years of 2006-2010 (see appendix 2 for more detailed figures from the analysis). The strongest linkages were found from France and its connections to other countries where the arithmetic mean of the correlation coefficient is above 0,9. However, all the countries showed strong levels of correlation that appear to be significant by having high levels of adjusted R^2 and in most cases the results were significant at the level of 1%.

This part of the analysis introduces of the countries separately in order to scrutinize the countries' correlation individually to each of the countries. Consequently, each country is an dependent variable in turn.

The United Kingdom as a Dependent Variable

In the analysis where the United Kingdom acts as a dependent variable the asset co-movement in the stock markets remains strong by looking at the correlation coefficient where the arithmetic mean is 0,784. A common feature for all of these country pairs is that the correlation coefficient increases from year 2007 to 2008, which can be considered to be a causal reaction of the start of GFC. In case of Spain, GB-ES correlation varies 0,587-0,827 the results denote a change of 0,587 (2007) to 0,827 (2008) during the GFC.

The correlation between the GB-DE is fairly strong, varying 0,721-0,871 throughout all the years between 2006 and 2010. However, it is notable that the only value that exceeds 0,8 occurs in year 2008 (0,871) for GB-DE, which again can be based on the beginning of the crisis period. For GB-FR, the correlation varies 0,814-0,908. *Vice versa* to the GB-DE country-pair, the correlation decreases from 0,908 (2007) to 0,662 (2008), which states the effect of the GFC is opposite and hence, less contagion between these countries.

By looking at the correlation coefficients for GB-IT, the values range 0,730-0,870 where the highest correlation (0,870) is captured from year 2008. The same phenomenon of increased

correlation during the beginning of GFC is present in the GB-IT country-pair when 0,801 (2007) increases to 0,870 (2008). Table 9 indicates the exact values for each year with their significance levels.

Table 9: Correlation coefficients for the United Kingdom as a dependent variable

Country	06		07		08		09		10	
	coef.	*t*	*coef.*	*t*	*coef.*	*t*	*coef.*	*t*	*coef.*	*t*
GB-SP	0,817***	9,914	0,587***	5,024	0,827***	10,208	0,715***	5,015	0,731***	7,505
GB-DE	0,797***	9,244	0,871***	7,596	0,871***	12,227	0,721***	7,208	0,764***	8,294
GB-FR	0,814***	9,821	0,908***	15,034	0,662***	6,124	-0,008	-0,058	0,898	10,022
GB-IT	0,761***	8,220	0,801***	9,260	0,870***	12,210	0,730***	4,002	0,752***	7,974

*Note: *,** and *** refer to statistical significance at the 10%, 5% and 1% levels, respectively.*

France as a Dependent Variable

As stated in the beginning of the chapter, contagion is captured in every variable combinations, France included. The arithmetic mean of the correlation coefficients is 0,919, which again states for a strong correlation between France and other countries. For the FR-DE country-pair, results of contagion effects can be spotted by having values 0,907-0,966. The FR-DE country-pair is also experiencing an increase in the correlation coefficient after the hit of the GFC stating an increase from 0,907 (2007) to 0,955 (2008).

In the case FR-GB, the correlation ranges between 0,898-0,947, which again, illustrates a strong correlation. However, the correlation does not have a significant change during the beginning of the GFC and the value rather remains the same (from 0,943 (2007) to 0,940 (2008)). Furthermore, FR-IT indicates equivalent results in terms of correlation when the values range 0,898-0,979. The comparison between the years 2007 and 2008 could not have been made due to the insignificant result of the year 2007. Nevertheless, the year 2006 states for a correlation level of 0,806 which has increased (0,979) by the time the recession has hit in the economy in

2008. The same pattern continues with Spain since the correlation varies 0,754-0,919 and additionally, the correlation increases from 0,754 (2007) to 0,919 (2008). Table 10 illustrates the yearly correlation levels.

Table 10: Correlation coefficients for France as a dependent variable

Country	06		07		08		09		10	
	coef.	*t*	*coef.*	*t*	*coef.*	*t*	*coef.*	*t*	*coef.*	*t*
FR-GB	0,947***	20,633	0,943***	14,282	0,940***	19,064	0,877***	7,551	0,898***	14,285
FR-IT	0,898***	14,282	0,212	1,520	0,979***	7,192	0,963***	25,015	0,932***	17,950
FR-SP	0,899***	14,383	0,754***	7,962	0,919***	16,159	0,915***	16,159	0,879	12,917
FR-DE	0,966***	26,095	0,907***	14,954	0,955***	22,201	0,959***	23,326	0,936***	18,690

*Note: *,** and *** refer to statistical significance at the 10%, 5% and 1% levels, respectively.*

Germany as a Dependent Variable

Germany follows the same pattern in terms of a strong correlation between the dependent and independent variables. The arithmetic mean for the correlation coefficients is 0,861 which indicates a strong correlation between the variables, which however, is a bit lower comparing to France and its independent variables (0,919). In addition, the impact of the GFC appears to be present in Germany and its country-pairs.

The correlation between DE-GB fluctuates between 0,721-0,871 throughout the years between 2006 and 2010. The increase in correlation from 0,739 (2007) to 0,871 (2008) is a result of the GFC. In addition, by looking at DE-IT the correlation coefficient varies 0,781-0,871 and the change from 2007 to 2008 is an increase from 0,781 to 0,943.

The correlation for DE-ES varies 0,739-0,942 and the effect of the GFC appears, again, by changing from 0,739 (2007) to 0,942 (2008). The last country-pair, DE-FR, has a strong correlation that ranges between 0,907-0,966 during the years 2006-2010. The influence of GFC

exists similarly in this case when the coefficient increases from 0,907(2007) to 0,955 (2008). The correlation coefficients can be found from table 11.

Table 11: Correlation coefficients for Germany as a dependent variable

Country	06		07		08		09		10	
	coef.	*t*	*coef.*	*t*	*coef.*	*t*	*coef.*	*t*	*coef.*	*t*
DE-GB	0,797***	9,244	0,739***	7,596	0,871***	8,448	0,721***	7,208	0,764***	6,754
DE-IT	0903***	14,713	0,781***	8,673	0,943***	19,721	0,853***	11,328	0,857***	11,653
DE-SP	0,898***	14,277	0,739***	7,593	0,942***	19,476	0,882***	12,966	0,765***	8,327
DE-FR	0,966***	26,095	0,907***	14,954	0,955***	22,201	0,959***	23,326	0,936***	18,690

*Note: *,** and *** refer to statistical significance at the 10%, 5% and 1% levels, respectively.*

Italy as a Dependent Variable

Italy is not an exception in terms of following the pattern of contagion effects. Consequently, the arithmetic mean of Italy and the independent variables is 0,8322. This, likewise, states for a strong correlation between the country-pairs. By looking at the correlation levels individually, IT-ES varies 0,706-0,940 throughout the years 2006-2010. The most significance change occurs in 2007-2008 when the coefficient increases from 0,706 to 0,920. In the case of IT-GB, the correlation still remains strong but a bit weaker comparing to IT-ES. The correlation coefficient ranges between 0,730-0,870 for IT-GB and the correlation increases from 0,801 (2007) to 0,870 (2008) during the GFC. The correlation, however, decreases again after 2008 by dropping to 0,730 in 2009.

The trend continues with the country-pairs IT-DE and IT-FR. The fluctuation in correlation varies 0,781-0,943 and 0,897-0,960 respectively. By looking at the correlations, one can see that the correlation for IT-FR appears to be a bit stronger and the exact correlations can be seen from table 12. The impact of the GFC is present, especially for IT-DE where the coefficient

increases from 0,781 (2007) to 0,943 (2008). For IT-FR, the correlation does not increase too much, from 0,932 (2007) to 0,960 (2008) and additionally, the correlation remains to be rather close to 0,9 for IT-FR.

Table 12: Correlation coefficients for Italy as a dependent variable

Country	06		07		08		09		10	
	coef.	*t*	*coef.*	*t*	*coef.*	*t*	*coef.*	*t*	*coef.*	*t*
IT-SP	0,864***	11,995	0,706***	6,908	0,920***	16,303	0,906***	14,874	0,940***	19,216
IT-GB	0,761***	8,220	0,801***	9,260	0,870***	8,518	0,730***	7,408	0,752***	7,974
IT-DE	0,903***	14,713	0,781***	8,673	0,943***	19,721	0,853***	5,945	0,857***	11,653
IT-FR	0,897***	14,055	0,932***	15,427	0,960***	23,858	0,901***	14,406	0,931***	17,655

*Note: *,** and *** refer to statistical significance at the 10%, 5% and 1% levels, respectively.*

Spain as a Dependent Variable

By looking at the correlation coefficients of Spain, one can state that the contagion effect is bi-directional for every country since Spain also states for a strong correlation between its independent variables in the stock market. The arithmetic mean for Spain and the independent variables is hold to be 0,830. One can see the yearly correlation coefficients in table 13. ES-FR ranges between 0,754-0,919 and the same phenomenon, the increase of coefficient after evoke of the GFC, is present: the coefficient increases from 0,754 (2007) to 0,919 (2008). ES-GB varies 0,587-0,827, which is a bit less than some of the other country-pairs. It appears that the correlation that contains a variable that is GB tends to have a bit weaker correlation, even though it is still classified mostly to be strong. The most significant change occurs in 2007 when 0,587 increases to 0,827 in 2008.

Likewise ES-DE and ES-IT indicate equivalent results in terms of the effect of the GFC and a strong correlation. ES-DE varies 0,739-0,942 and the most significance increase occurs again in the period of crisis: from 0,739 (2007) to 0,942 (2008). However, the correlation decreases a bit from 2008 gradually; from 0,942 (2008) to 0,0882 (2009) and from that to 0,765 (2010). ES-IT also has a strong correlation and ranges between 0,706-0,940. Correlation coefficient increases again from 0,706 in 2007 to 0,920 in

2008. Hence, by looking at Spain and all the other countries contagion effects are bi-directional and it appears to have a strong correlation.

Table 13: Correlation coefficients for Italy as a dependent variable

Country	06		07		08		09		10	
	coef.	*t*	*coef.*	*t*	*coef.*	*t*	*coef.*	*t*	*coef.*	*t*
ES-FR	0,899***	14,383	0,754***	7,962	0,919***	16,159	0,915***	15,696	0,879***	12,917
ES-GB	0,817***	9,914	0,587***	5,024	0,827***	5,638	0,827***	5,638	0,715***	7,080
ES-DE	0,898***	14,277	0,739***	7,593	0,942***	19,476	0,882***	12,966	0,765***	8,327
ES-IT	0,864***	11,995	0,706***	6,908	0,920***	16,303	0,906***	14,874	0,940***	19,216

*Note: *,** and *** refer to statistical significance at the 10%, 5% and 1% levels, respectively.*

As discussed in this chapter, the contagion effects are present in all cases and it appears that the correlation between countries increases in periods of financial distress. These results that show bi-directional contagion can be interpreted as a downside to the economic integration since a crash in one of these markets means that there is a very high chance other market follows the same pattern. It also appears that the correlation is a bit weaker between the United Kingdom and other countries which can be due to the fact that other countries beside the United Kingdom are part of the EMU.

However, a few exceptions were found in terms of the impact of the GFC by having a decreasing coefficient (GD-DE in 2007-2008) and coefficients that almost stayed at the same level and thus, did not increase due to the GFC (FR-GB in 2007-2008).

5. Discussion and Critical Reflection

In the beginning of the paper, the studied phenomena of flight-to-quality and contagion were addressed and simultaneously they generate a base for the research questions that study the impact of the GFC on cross-asset and cross-country linkages within the five largest economies in the EU. In other words, the paper addresses how the tendencies of cross-asset movements are affected by the GFC and whether contagion increases in the stock markets due to a period of market turmoil. The first hypothesis is derived from the results of Hartmann *et al.* (2004), which state that stock markets have the tendency to co-crash more often than bond markets with contagion having the same likelihood than flight-to-quality. The second hypothesis for studying contagion assumes that the correlation coefficient is strong due to the economic integration within the EU. The previous literature suggests that asset classes tend to co-move more strongly during crisis periods mainly in the form of contagion effects. However, there have been different results in previous studies showing whether the contagion effects tend to be bi-directional or not.

5.1. Flight-to-Quality and the Diversification of Unsystematic Risk

The OLS method is used to analyze the impact of an independent variable (bonds) to a dependent variable (stocks) in the part of studying the phenomenon of flight-to-quality. The theory of flight-to-quality indicates that the prices of government bonds increase in a relation to stocks as a significant decrease in the correlation coefficient.

The results of the analysis suggest that flight-to-quality does exist in crisis periods which makes the investors more aware of the increased risk and hence, they tend to diversify the unsystematic risk in their portfolios in order to guarantee solid returns from their investments. Consequently, it appears that during the market turmoil investors are less likely to invest in risky assets and they rather ensure their profit gains by investing in safer, but also less high-yielding assets, due to the fear of losing their investments. The greatest evidence to flight-to-quality phenomenon is provided by scrutinizing the results of Germany. In addition, the United Kingdom has similar tendencies to Germany indicating the presence of flight-to-quality. Thus, by including the United Kingdom for this study it can be concluded that flight-to-quality does not only exist in

the Eurozone and possible flight-to-quality phenomena can be expected from other countries that do not use Euro as their currency. However, it appears that flight-to-quality is a country specific phenomenon that cannot be generalized to all the markets that are hit by a shock. For instance, the market behavior for Spain and Italy indicate different results than the United Kingdom and Germany despite the fact that some of the individual years of these countries could not be scrutinized on a yearly basis in this analysis. In addition, France that can be classified to have similar characteristics as Germany by being the core of the Eurozone does not seem to follow the same path since the correlation coefficient is positive and rather states contagion than flight-to-quality. Hence, this indicates for another evidence for characterizing flight-to-quality as a country specific phenomenon.

Nevertheless, it is worth noting that both Spain and Italy had negative correlation coefficients in 2007 and by the end of this study period in 2012, the correlation coefficients have not only turned positive but also stating for a certain amount of correlation between the two assets. The different results can be derived from the distinct economic conditions of the countries. As discussed earlier in chapter 2, Italy and Spain are considered to be the peripheral countries of the Eurozone whereas France and Germany form the core for the monetary union according to Lapavitsas *et al.* (2012). Therefore, the fact that the governments of Spain and Italy had run into debt during the EZDC can be argued to have an impact on the behavior of the investors in the market. If the investors do not trust the governments and fail to hold the idea of risk-free investments that are usually regarded as government bonds *i.e.* treasury bills, the bond market cannot be expected to boom. Hence, flight-to-quality does not necessarily diversify the risk if the governments are in trouble and there is a fear of insolvency and possible default of the governments. This explains why flight-to-quality fails to exist in Spain and Italy and contagion, on the other hand, rises in terms of positive asset correlation.

In sum, the question about the tendencies of two asset class co-movements posed in the beginning of this study are addressed in this chapter by stating that a crisis period that counts as the GFC in this study has an impact on the co-movements in the stock-bond markets. These tendencies can be counted to be country specific and the occurrence of either flight-to-quality or contagion phenomena depends on the trust that investors have on the market or the governments.

5.2. Contagion and the Disadvantage of Economic Integration

In terms of contagion, Forbes & Rigobon (2012) argue that if one market experiences a shock, it has a ripple effect to other markets generating a significant increase in the asset co-movement in a case of two markets that are classified to be moderately correlated during the times when stability exists. However, an opposite phenomenon to contagion that is 'interdependence' can be identified if the correlation coefficient remains unchanged or the increase is insignificant. In addition, Hartmann *et al.* (2004) state that when looking at the results from the study it can be seen that neither in the case of contagion nor in the case of flight-to-quality the national borders tend to limit their spill-over effects. Thus, it can be interpreted as a potential downside to international financial integration from a point of view of domestic financial market stability.[76] The most critical inference generated from the results is that (like Hartmann *et al.* (2004) argued in their more general results) inside Europe, the national borders tend not to stop the stock market crisis from spilling over to other countries. As the results described in chapter 4 show, the correlation (*i.e.* in the form of contagion) seemed to increase during 2008-2009 when the GFC started. Thus, the contagion effect seems to have gotten stronger after the crisis hit the stock markets. In addition, by looking at the stock returns of each country, it can be stated that all the markets crashed in the same week in October 2008, which supports the phenomenon of contagion.

According to the second hypothesis mentioned earlier in this paper, this could be expected. Thus, the high level of economic integration inside the European Union seems to have a major disadvantage in crisis periods. It is worth noting that looking at the results from this study it does not seem to account where the crisis breaks off since the contagion effects seem to be bi-directional between these five countries. Thus, preventing the crashes from one country to spill over to another seems to be very challenging if not merely impossible inside the European Union.

However, one exception was found in terms of the impact of the GFC where the United Kingdom-Germany variables had a decreasing coefficient. In addition, the correlation between the United Kingdom and other countries were found to be a bit weaker than the other countries' correlation. This may be due to the fact that the United Kingdom is not part of the EMU. The

[76] Hartmann *et al*. 2004, p.323

strongest correlations were found from Germany and France that present the core countries of the EU, and Italy and Spain that can be considered as peripheral countries according to Lapavitsas (2012) also had strong correlations but however, a bit weaker than the core countries.

Hence, the results of this study answer to the second research question "*How have the stock co-movements changed across countries prior to and during the crisis period?*" by showing a stronger co-movement between national stock markets after the GFC began to affect in Europe. Additionally, it can be stated that it does not seem to matter where the crisis breaks out since the results show bi-directional contagion and thus, the crisis' probabilities to spill over to another country are relatively high. Therefore, it can be concluded that the theory and observations gathered from previous research are mostly in accordance with the results generated from this case study. The stronger level of contagion compared to other studies is most likely due to the high level of economic integration inside the European Union.

Earlier in the introduction chapter it is mentioned that the paper studies the cross-asset linkages from the perspective of an individual investor. Thus, looking at the results and based on the critical discussion in this chapter, some conclusions can be gathered for an individual investor. First, depending on which country of the five largest economies is looked at, there are different results to whether the investors have sought to invest in government bonds during a crisis period (as for instance in the case of Germany) or whether the crisis has spilled over from stocks to bonds (as for instance in the case of France). Second, during a crisis period, it is rather irrelevant in which country's stock market the money is invested in, since the crashes seem to spill over to other EU countries.

6. Conclusion

Previous research shows that asset markets tend to co-move more strongly during financial distress. However, the existing literature on the subject lacks somewhat in terms of studying the effects of GFC to the European stock and bond market co-movements. Hence, the purpose of this study is to shed light on the phenomena of contagion and flight-to-quality by conducting an OLS regression model. Consequently, the five largest European markets measured by GDP,

have been studied individually during 2006-2012 in order to capture if the asset classes tend to co-move more strongly during the crisis period and simultaneously the direction of these co-movements (contagion or flight-to-quality). Additionally, a cross-country analysis has been conducted to study the stock market co-movements across borders between 2006 and 2010 that counts for a business cycle.

The most significant results from the cross-asset analysis are drawn from the United Kingdom, Germany and France. The cross-asset analysis shows that the GFC did not have much effect on the cross-asset co-movements in the United Kingdom with the exception of a plausible small flight-to-quality effect. Germany, however, has experienced a clearer phenomenon of flight-to-quality where investors have sought to purchase government bonds due to a crash in the stock market. In contrast, France shows some results of having experienced contagion where both stock and bond markets have co-moved in the same direction. Spain and Italy, on the other hand, were captured to have an inverse effect indicated by the correlation coefficient that constitutes from contagion. Thus, it appears that flight-to-quality as a phenomenon is country specific.

In the cross-country analysis it showed that all the five countries studied in this paper (the United Kindom, Germany, France, Spain and Italy) show bi-directional contagion effects with each other which in most cases get stronger during the GFC approximately in 2008-2009. This can be seen as a downside to international economic integration, which is extremely high in the European Union.

Overall, this paper has been conducted under the possibility of ensuring that the investors become more aware of cross-country and individual country-related risks when investing in assets during a market distress. It seems that the only certain way to diversify some of the risk is to invest in government bonds that are not under the speculation of default. However, the diminishing risk of investing in safer assets will not ensure that there are no capital losses and thus, investors have to always be aware of the current trends in the market.

7. Limitations

The paper encounters some limitations due to the chosen method, currency issues and not capturing the cross-asset linkages within a cross-country analysis. A simple regression model (OLS) does not capture non-linear relationships and it has limitations to capture the time varying volatility. Thus, a (G)ARCH based model would have possibly been better to capture the time varying volatility in a weekly interval which is now done annually to capture the time varying volatility. Despite the fact that Hartmann *et al*. (2004) use ARCH-based Statistical Extreme Value Analysis, the model used in this study is based on OLS due to the difficulties of establishing such a high level study in terms of time and analytical computer skills that are beyond bachelor's level. Thus, without the limitations that the Hartmann *et al.*'s (2004) highly advanced ARCH-based method sets for conducting a similar study it still remains as the ideal type of study method. Additionally, one limitation of the OLS method is that it only provides results for the regressions. In contrast, the method used by Hartmann *et al.* (2004) derives probabilities that might have a more significant meaning in terms of predicting the asset linkages in future crises periods. However, since this is a case study it is not the purpose of this paper to generate generalized probabilities but instead, to understand the GFC's effects to the European markets' asset linkages.

Another issue arises in terms of the chosen method that is based on the fact that it is extremely time consuming to study cross-asset linkages within cross-country analysis on a yearly basis. Thus, the study focuses on contagion in stock markets in the cross-country analysis without the impact of cross-asset linkages across countries.

In addition, the exchange rate might have an impact on the stock prices when converting Pounds (£) to Euros (€). Therefore, it might bias the stock returns in terms of studying contagion. However, when studying cross-asset linkages the United Kingdom's own currency is used because it does not require an overlapping data with another currency.

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Appendices

Appendix 1. Cross-asset regressions

H0: beta=0

GB	Year	t-statistics	SLOPE	Adj.R^2	r	Autocor.	Heteroskedasticity	P-value	Reject/Not Rejected	Robust SE
	2006	-0,518	-0,433	-0,014	-0,060	2,24	NO	0,607	Not rejected	
	2007	-2,989	-2,016	0,139	-0,391	2,55	NO	0,004	Reject	
	2008	-2,383	-2,205	0,087	-0,324	2,18	NO	0,021	Reject	
	2009	-3,400	-2,287	0,177	-0,436	1,52	NO	0,001	Reject	
	2010	-2,407	-1,804	0,087	-0,333	2,09	NO	0,020	Reject	
	2011	-4,170	-3,102	0,250	-0,509	2,37	NO	0,000	Reject	
	2012	-5,448	-2,368	0,369	-0,618	2,23	NO	0,000	Reject	
DE	2006	-0,901	-1,104	-0,003	-0,101	2,25	NO	0,372	Not rejected	
	2007	-4,158	-3,717	0,249	-0,518	2,87	NO	0,000	Reject	
	2008	-2,830	-3,606	0,125	-0,378	2,48	NO	0,007	Reject	
	2009	-4,356	-4,652	0,268	-0,531	1,36	NO	0,000	Reject	
	2010	-5,181	-3,865	0,345	-0,596	2,43	NO	0,000	Reject	
	2011	-4,226	-3,955	0,255	-0,522	2,25	NO	0,000	Reject	
	2012	-5,051	-3,316	0,333	-0,579	2,15	NO	0,000	Reject	
FR	2006	0,997	1,119	-0,000	0,141	2,24	NO	0,324	Not rejected	
	2007	4,244	3,744	0,253	0,518	2,57	NO	0,000	Reject	
	2008	2,570	3,174	0,100	0,345	2,5	NO	0,013	Reject	
	2009	2,876	3,363	0,126	0,380	1,8	NO	0,006	Reject	
	2010	2,936	4,431	0,204	0,469	2,26	YES	0,003	Reject	1,509
	2011	-1,184	1,113	0,007	0,141	2,22	YES	0,242	Not rejected	1,509
	2012	1,527	1,022	0,025	-0,213	2,19	NO	0,133	Not rejected	

IT	2006	-0,876	-0,778	-0,004	-0,087	2,2	NO	0,385	Not rejected	
	2007	-4,926	-4,410	0,317	-0,575	2,33	NO	0,000	Reject	
	2008	-0,891	-1,112	-0,004	-0,126	2,42	NO	0,377	Not rejected	
	2009	-0,055	-0,092	-0,020	-0,008	1,73	NO	0,956	Not rejected	
	2010	5,393	3,641	0,355	0,606	2,08	NO	0,000	Reject	
	2011	3,652	1,704	0,197	0,463	2,37	NO	0,001	Reject	
	2012	6,038	2,187	0,414	0,653	2,09	NO	0,000	Reject	
ES	2006	-0,941	-0,973	-0,002	0,135	1,92	NO	0,352	Not rejected	
	2007	-3,137	-2,817	0,152	-0,412	2,47	NO	0,003	Reject	
	2008	-1,877	-2,354	0,049	-0,262	2,83	NO	0,067	Reject	
	2009	-0,712	-0,820	-0,010	-0,103	1,82	NO	0,480	Not rejected	
	2010	3,095	2,522	0,268	0,533	2,06	YES	0,002	Reject	0,812
	2011	2,259	1,264	0,128	0,383	2,28	YES	0,024	Reject	0,588
	2012	5,219	1,673	0,348	0,602	2,38	NO	0,000	Reject	

Appendix 2. Cross-country regressions.

H0: beta=0

GB-FR	Year	t-statistics	SLOPE	Adj.R^2	r	Autocor.	Heteroskedasticity	P-value	Reject/Not Rejected	Robust SE
	2006	9,821	0,845	0,656	0,814	2,31	NO	4E-13	Reject	
	2007	15,034	0,871	0,821	0,908	2,37	NO	9E-20	Reject	
	2008	6,124	1,396	0,426	0,662	2,42	NO	2E-07	Reject	
	2009	-0,058	-0,009	-0,020	-0,008	1,87	NO	1E+00	Not Rejected	
	2010	10,022	0,793	0,665	0,898	2,35	NO	2E-13	Reject	

GB-DE	2006	9,244	0,906	0,628	0,797	2,37	NO	3E-12	Reject	
	2007	7,596	0,772	0,536	0,871	2,32	NO	9E-10	Reject	
	2008	12,277	1,000	0,753	0,871	2,46	NO	2E-16	Reject	
	2009	7,208	0,786	0,509	0,721	1,88	NO	4E-09	Reject	
	2010	8,294	0,667	0,575	0,764	2,18	NO	7E-11	Reject	
GB-ES	2006	9,914	0,797	0,660	0,817	1,63	NO	3E-13	Reject	
	2007	5,024	0,571	0,330	0,587	2,13	NO	7E-06	Reject	
	2008	10,208	0,917	0,678	0,827	2,68	NO	1E-13	Reject	
	2009	5,015	0,728	0,500	0,715	2,04	YES	5E-07	Reject	0,127
	2010	7,505	1,054	0,525	0,731	2,25	NO	1E-09	Reject	
GB-IT	2006	8,220	0,594	0,571	0,761	2,34	NO	9E-11	Reject	
	2007	9,260	0,767	0,633	0,801	2,36	NO	3E-12	Reject	
	2008	12,210	0,924	0,751	0,870	2,28	NO	2E-16	Reject	
	2009	4,002	1,044	0,523	0,730	1,89	YES	6E-05	Reject	0,219
	2010	7,974	0,934	0,555	0,752	2,15	NO	2E-10	Reject	
FR-GB	2006	20,633	0,802	0,894	0,947	2,36	NO	8E-26	Reject	
	2007	19,714	0,890	0,887	0,943	1,9	NO	1E-24	Reject	
	2008	19,064	0,976	0,880	0,940	2,11	NO	5E-24	Reject	
	2009	7,551	0,766	0,763	0,877	2,05	YES	4E-14	Reject	0,091
	2010	14,285	0,793	0,802	0,898	2,67	NO	4E-19	Reject	
FR-IT	2006	14,282	0,675	0,802	0,898	2,03	NO	4E-19	Reject	
	2007	1,520	0,164	0,025	0,212	2,48	NO	1E-01	Not Rejected	
	2008	7,192	1,204	0,958	0,979	2,13	YES	6E-13	Reject	0,167
	2009	25,015	1,514	0,925	0,963	1,86	NO	1E-29	Reject	
	2010	17,950	1,018	0,865	0,932	2,2	NO	3E-23	Reject	

FR-ES	2006	14,383	0,845	0,804	0,899	1,49	NO	3E-19	Reject	
	2007	7,962	0,712	0,560	0,754	1,55	NO	3E-10	Reject	
	2008	16,159	0,910	0,841	0,919	2,45	NO	5E-21	Reject	
	2009	15,696	0,886	0,833	0,915	2,05	NO	2E-20	Reject	
	2010	12,917	1,115	0,768	0,879	2,39	NO	2E-17	Reject	
FR-DE	2006	26,095	1,057	0,931	0,966	1,78	NO	2E-30	Reject	
	2007	14,954	0,920	0,819	0,907	2,34	NO	1E-19	Reject	
	2008	22,201	0,979	0,909	0,955	2,73	NO	7E-27	Reject	
	2009	23,326	0,993	0,917	0,959	2,27	NO	8E-28	Reject	
	2010	18,690	0,718	0,874	0,936	1,57	NO	6E-24	Reject	
DE-GB	2006	9,244	0,702	0,628	0,797	2,44	NO	3E-12	Reject	
	2007	7,596	0,707	0,536	0,739	2,28	NO	9E-10	Reject	
	2008	8,448	0,759	0,753	0,871	1,89	YES	0E+00	Reject	0,090
	2009	7,208	0,661	0,509	0,721	2,32	NO	4E-09	Reject	
	2010	6,754	0,876	0,575	0,764	1,57	YES	1E-11	Reject	0,131
DE-IT	2006	14,713	0,716	0,811	0,903	2,01	NO	1E-19	Reject	
	2007	8,673	0,716	0,602	0,781	2,65	NO	2E-11	Reject	
	2008	19,721	0,873	0,887	0,943	2,27	NO	1E-24	Reject	
	2009	11,328	1,119	0,722	0,853	2,12	NO	4E-15	Reject	
	2010	11,653	1,221	0,729	0,857	1,83	NO	1E-15	Reject	
DE-ES	2006	14,277	0,771	0,802	0,898	1,6	NO	4E-19	Reject	
	2007	7,593	0,688	0,536	0,739	1,78	NO	9E-10	Reject	
	2008	19,476	0,909	0,885	0,942	2,36	NO	2E-24	Reject	
	2009	12,966	0,824	0,773	0,882	2,41	NO	3E-17	Reject	
	2010	8,327	1,265	0,577	0,765	2,05	NO	6E-11	Reject	

DE-FR	2006	26,095	0,882	0,931	0,966	1,78	NO	2E-30	Reject	
	2007	14,954	0,895	0,819	0,907	2,45	NO	1E-19	Reject	
	2008	22,201	0,930	0,909	0,955	2,72	NO	7E-27	Reject	
	2009	23,326	0,925	0,917	0,959	2,51	NO	8E-28	Reject	
	2010	18,690	1,221	0,874	0,936	1,44	NO	6E-24	Reject	
IT-ES	2006	11,995	1,080	0,740	0,864	1,88	NO	3E-16	Reject	
	2007	6,908	0,717	0,488	0,706	1,86	NO	1E-08	Reject	
	2008	16,303	0,960	0,843	0,920	2,16	NO	3E-21	Reject	
	2009	14,874	0,646	0,817	0,906	1,71	NO	1E-19	Reject	
	2010	19,216	1,090	0,880	0,940	2,47	NO	2E-24	Reject	
IT-GB	2006	8,220	0,975	0,571	0,761	2,43	NO	9E-11	Reject	
	2007	9,260	0,836	0,633	0,801	2,29	NO	3E-12	Reject	
	2008	8,518	0,818	0,751	0,870	1,78	YES	0E+00	Reject	0,096
	2009	7,408	0,511	0,523	0,730	2,12	NO	2E-09	Reject	
	2010	7,974	0,605	0,555	0,752	1,85	NO	2E-10	Reject	
IT-DE	2006	14,713	1,314	0,811	0,903	2,03	NO	1E-19	Reject	
	2007	8,673	0,852	0,602	0,781	2,63	NO	2E-11	Reject	
	2008	19,721	1,019	0,887	0,943	2,32	NO	1E-24	Reject	
	2009	5,945	0,651	0,722	0,853	1,9	YES	3E-09	Reject	0,109
	2010	11,653	0,602	0,729	0,857	2,14	NO	1E-15	Reject	
IT-FR	2006	14,055	1,195	0,800	0,897	2,05	NO	1E-18	Reject	
	2007	15,427	1,018	0,828	0,932	2,46	YES	0E+00	Reject	0,065
	2008	23,858	1,011	0,920	0,960	2,16	NO	3E-28	Reject	
	2009	14,406	0,663	0,808	0,901	1,88	NO	5E-19	Reject	
	2010	17,655	0,852	0,863	0,931	2,27	NO	1E-22	Reject	

ES-FR	2006	14,383	0,956	0,804	0,899	1,79	NO	3E-19	Reject	
	2007	7,962	0,799	0,560	0,754	1,47	NO	3E-10	Reject	
	2008	16,159	0,928	0,841	0,919	2,26	NO	5E-21	Reject	
	2009	15,696	0,945	0,833	0,915	1,93	NO	2E-20	Reject	
	2010	12,917	0,694	0,768	0,879	2,54	NO	2E-17	Reject	
ES-GB	2006	9,914	0,837	0,660	0,817	2,02	NO	3E-13	Reject	
	2007	5,024	0,603	0,330	0,587	2,02	NO	7E-06	Reject	
	2008	5,638	0,747	0,678	0,827	1,9	YES	2E-08	Reject	0,132
	2009	7,080	0,701	0,500	0,715	2,12	NO	6E-09	Reject	
	2010	7,505	0,507	0,525	0,731	1,93	NO	1E-09	Reject	
ES-DE	2006	14,277	1,045	0,802	0,898	1,91	NO	4E-19	Reject	
	2007	7,593	0,793	0,536	0,739	1,7	NO	9E-10	Reject	
	2008	19,476	0,976	0,885	0,942	2,15	NO	2E-24	Reject	
	2009	12,966	0,944	0,773	0,882	2,05	NO	3E-17	Reject	
	2010	8,327	0,463	0,577	0,765	2,33	NO	6E-11	Reject	
ES-IT	2006	11,995	0,691	0,740	0,864	2,17	NO	3E-16	Reject	
	2007	6,908	0,695	0,488	0,706	1,8	NO	1E-08	Reject	
	2008	16,303	0,883	0,843	0,920	1,88	NO	3E-21	Reject	
	2009	14,874	1,272	0,817	0,906	1,57	NO	1E-19	Reject	
	2010	19,216	0,810	0,880	0,940	2,44	NO	-2E-02	Reject	

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